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DRYLAND PASTURE AND CROP CONDITIONS AS SEEN BY HCMM

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Progress Report for Period
April — July 1980

Prepared for

NASA-Goddard Space Flight Center
Greenbelt, Maryland 20771

Contract NAS5-24383

TEXAS A&M UNIVERSITY
REMOTE SENSING CENTER
COLLEGE STATION, TEXAS

DRYLAND PASTURE AND CROP CONDITIONS AS SEEN BY HCMM

By

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1.0 BACKGROUND AND SUMMARY

1.1 Background

This 32-month project is an extension of several other projects which involve estimates of wheat yield (Harlan *et al.*, 1978), green biomass (Deering *et al.*, 1977) and watershed run-off coefficient (Blanchard, 1978) using visible, near infrared and passive microwave data. In each estimate, soil moisture content is a major determining factor. The hypothesis of this study is that high resolution thermal infrared data, such as those received from HCMM, will enhance estimates of soil moisture content. Therefore, the three objectives of this project, as given in the statement of contract NAS5-24383, are:

1) to assess the capability for determining wheat and pasture canopy temperatures in a dryland farming region from HCMM data.

2) to assess the capability for determining soil moisture from HCMM data in dryland crops (winter wheat) from adjacent range lands.

3) to determine the relationship of HCMM-derived soil moisture and canopy temperature values with the condition of winter wheat and dryland farming areas during the principal growth stages.

To accomplish these objectives, measurements will be obtained at three levels: ground truth, aircraft, and satellite. The site selected for these measurements are on the Washita River watershed, near Chickasha, Oklahoma. The area has a dense USDA/SEA-AR network of rain gages, and rangeland and dryland winter wheat are often adjacent to each other. Ground truth data include canopy and lake surface temperatures, neutron probe and gravimetric soil moisture samples, and

daily precipitation data. The aircraft collected day/night thermal scanner data and aerial photos of commercial wheat and pasture fields; HCMM has collected day/night thermal imagery over the same site, in addition to a site near Colby, Kansas. Data collected from each level will be correlated in two ways:

1) thermal (HCMM and aircraft) parameters of soil moisture and crop canopy temperatures will be derived,

2) a technique will be developed to calculate the antecedent precipitation indices from the thermal parameters of soil moisture and canopy temperatures, and

1.2 Summary

Accomplishments during the tenth period of the contract (April-July 1980) include:

1. Receiving HCMM CCT data,
2. Analyzing day/day thermal IR differences between data from August 31 and October 17, and
3. Calculating atmospheric correction on HCMM pass dates using the RADTRA model.

Visible and IR HCMM data for July 29 was received during this period and will be analyzed during the next period.

Daytime thermal IR data from the Washita watershed on October 17 was compared with IR data on August 31--a drier date--covering the same area. The thermal difference was compared to API differences

between the two dates. A general relationship is apparent.

Temperature and moisture sounding data during HCMM passes were collected and used in the RADTRA model to calculate surface temperature corrections. Differences between corrections using lake temperatures and calculated temperatures were small.

2.0 ACCOMPLISHMENTS AND PROBLEMS

2.1 Accomplishments

During the tenth period we compared the day IR images on October 17 and August 31. Moisture conditions on August 31 were drier. Since October 17 was a clear day/night data set, day/day and day/night thermal IR differences in relation to API can be compared.

In addition, meteorological data on HCMM pass dates were collected and input into the RADTRA model provided by NASA/GSFC. The atmospheric corrections of surface temperatures were similar to corrections calculated by monitoring lake surface temperatures.

Day/Day Thermal IE Differences vs. API

Since day/day IR differences between the July 24 and July 13 images correlate well with API, we wanted to compare the relationship with the day/night relationship during the same period. Since the only extended period of day/night data is October, this is the data set which will be used.

August 31 is the date selected as the reference image having dry moisture conditions, and having land use growing conditions similar to conditions in October. API values throughout the watershed ranged from 0.15 to 0.80 cm. Comparing the October 6, 12 and 17 day IR images with this image we will have a series of day-day thermal differences to compare with the day/night thermal difference data. October 17 was the first date selected. API conditions for this date ranged from 0.05 to 1.20 cm. The storm during the first week of

October was still evident in northern areas of the watershed. The relationship between thermal differences and API is shown in Figure 1. The general relationship is evident and the scatter is about the same in the October 17/August 17 difference (R^2=0.43) compared to the July 24/June 13 thermal difference. The scatter is about the same as the day/night relationship with API (see Progress Report #9). Both day/day and day/night data will be filtered removing areas having less than 60% pasture in the area.

Atmospheric Correction

During the tenth period, meteorological information at Oklahoma City was collected coinciding with HCMM pass dates. The information was then input into the RADTRA model, developed at GSFC, to calculate surface temperature corrections as seen by the satellite. Corrections for various dates are included in Table 1. Note the corrections for July 24 and June 13. The difference between the two would give a 2.6°C temperature correction. The correction as determined by using surface lake temperatures is 1°C ±1°C. Considering the distance of the meteorological station from Chickasha--50 km--and possible errors in the atmospheric sounding, the two estimates are within error tolerance. Consequently, lake temperatures, if monitored continuously, may be an adequate and easier technique for correcting apparent surface temperatures.

2.2 Future Accomplishments

During the next period, we will filter the data for areas having greater than 60% pasture around each rain gage. This may give a

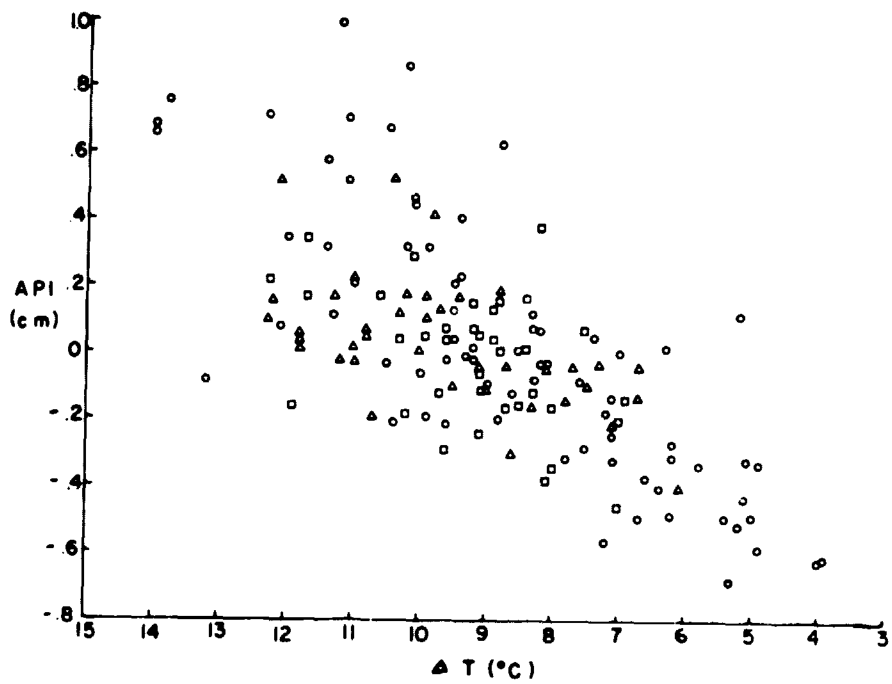

Figure 1. Day/Day thermal differences (October 17 - August 31) versus the corresponding API differences.

TABLE 1

CALCULATED SURFACE TEMPERATURE CORRECTIONS

HCMM Pass Date	Correction (°C)
July 13, 1978	1.40
July 24, 1978	3.89
October 17, 1978	0.37

better representation of day/day or day/night temperature differences versus API.

In addition, we will begin analyzing recently acquired CCT data. One date in particular will be July 29, 1978, a date where the storm pattern of July 21, 1978, is still evident.

Besides API, volumetric soil moisture will be compared to thermal IR data. Soil moisture data will be empirically modeled for HCMM passes between soil moisture measurements. The soil moisture and API relationships with thermal IR data will be compared.

Thermal atmospheric corrections using the RADTRA model will be analyzed further. Corrections as determined by RADTRA and monitored lake surface temperature data will be compared.

To complete the analyses, additional registered CCT data is still required. Data from two day/night registered dates, October 11/12 and 6/7, have not been received yet.

2.3 Problems

No problems have developed during this period.

3.0 SIGNIFICANT RESULTS

No significant results were obtained during this period.

4.0 FUNDS EXPENDED

During the tenth period (April - July 1980), a large portion of the funds was spent on salaries and wages. During this quarter, $3,270 were spent, bringing the total amount to $90,047, or 73% of the total budget. The cost extension has been added with termination of the contract on January 31, 1981. During the next period, computer processing of CCT data will again comprise a large portion of the quarterly expenditure. Table 2 gives a breakdown of the funds expended.

TABLE 2

Funds Expended

	First Five Quarters	Sixth Quarter	Seventh Quarter	Eighth Quarter	Ninth Quarter	Tenth Quarter
Supplies	577	115	0	55	1,536	31
Travel	3,224	0	268	1,745	1,161	458
Other Direct Costs	11,324	385	175	217	2,029	422
TOTAL OTHER DIRECT COSTS	15,125	505	443	2,017	4,726	911
Salaries & Wages	24,996	0	5,967	3,447	9,517	1,632
TOTAL INDIRECT COSTS	11,294	0	2,806	1,554	4,380	727
	51,315	505	9,216	7,018	18,723	3,270

5.0 AIRCRAFT AND SATELLITE DATA USAGE

All ordered CCT's have good quality, and can be processed on our TI 980 Computer. A few standing orders of day/night registered data remain. One day/night registered data set included the day visible and infrared data, but had omitted the Oklahoma site in the night IR, thermal difference and apparent thermal inertia. GSFC has been alerted to the problem and is correcting it.

We are still developing a normalization technique of daytime thermal IR data. We will use either solar radiation or air temperature as the normalization factor.

The REMOTE SENSING CENTER was established by authority of the Board of Directors of the Texas A&M University System on February 27, 1968. The CENTER is a consortium of four colleges of the University; Agriculture, Engineering, Geosciences, and Science. This unique organization concentrates on the development and utilization of remote sensing techniques and technology for a broad range of applications to the betterment of mankind.